demonstrated. There are granules in Chromatium and in Beggiatoa which stain red with haematoxylin, but they cannot be called chromatin on such evidence. There are no genuine nuclei in the sulfur bacteria.

In dealing with the genuine bacteria, the theory that bacteria are nuclei without cytoplasm is regarded as unfounded. After the best fixing agents neither Spirillum nor other bacteria show clear, less deeply staining ends. Bütschli's central body is nothing but the entire protoplast contracted by the plasmolysis of preparation. The contents of the bacterium cell consist of a lining of protoplasm along the wall and a central cavity which in elongated forms is chambered by protoplasmic septa. Present methods fail to demonstrate a nucleus. The more deeply staining granules are not nuclei, or chromatin granules. The relationship of the sulfur bacteria and all other bacteria to the Cyanophyceæ is merely one of loose, superficial morphology. They stand in closer relation to the Flagellatae.

Microtome sections from paraffine material were stained in the most approved manner, and the technique throughout was thoroughly up to date. The plates are exceptionally elegant, aud doubtless show what there is to be seen.—CHAS. J. CHAMBERLAIN.

A laboratory manual.[2]

SUCH is the name given to a little book by Principal Charles H. Clark, of Windsor Hall School. It seems to be the author's idea to furnish a large amount of suggestive material, from which work may be obtained either for elementary or more advanced courses; and he follows, as he states, "the lines suggested in the Report of the Committee of Ten." As the reviewer prepared the botanical part of that report, it was a matter of interest to him, not to say surprise, to see it take this expression. It has never fallen to our lot to be so puzzled by a schoolbook dealing with botany. It is a puzzle both as to its botany and as to its pedagogy. It claims to be adapted for use in elementary courses, but there is no adequate explanation of the terms used or of the structures or functions to which they apply; the terminology is utterly confusing and inconsistent; and there is no morphological thread whatsoever upon which the facts may be strung.

The author seems to have obtained a multitude of facts, but they are as incoherent as a sand bank; and what is worse, the essential structures are most frequently omitted. This is notably true in the treatment of the spermatophytes, where the morphologically important structures of the lower groups are entirely dropped, and the work is confined to the histology of the

[2] CLARK, CHARLES H.—A laboratory manual in practical botany. Small 8vo. pp. 271. *figs. 191*. New York, Cincinnati, Chicago: American Book Company. 96 cents.

sporophyte, and a little of its physiology. Such guidance may teach laboratory methods, may collect a mass of unrelated facts without any reference to their importance; but it never can result in a clear conception of plants.

A good teacher can manage to get along with a lot of poorly digested material, although it is an unnecessary burden, but misrepresentation is unpardonable. We do not have space to quote the many remarkable statements noted in a casual reading of this book, but we must justify our strictures by presenting a few.

The form of the plant (thallophyte) which bears simple spores is known as the *sporophyte* (p. 9).

The male gamete (in spermatophytes) is either the original nucleated protoplasm of the pollen grain, or is one of the nucleated cells formed by the division of that protoplasm in the formation of the male prothallium in a tube which grows out of the pollen grains (p. 11).

Seeds, in the higher plants, result from the fertilization of ovules by pollen grains. Seeds grow directly into ordinary plants when the conditions are favorable. Spores result from cell division. They contain no embryo and do not grow into ordinary plants (p. 36).

In the cells of certain modified leaves of this cluster (in mosses) minute antherozoids are borne (p. 38).

The oospore is raised up above the top of the female plant by a very slender stalk, the seta, and develops there into the sporophyte form of the plant (p. 38).

The enlarged top that develops on the female plant (in mosses) is a sporangium (p. 38).

No sexual reproduction is known to occur in this class (schizophytes). There is consequently no alternation of generations from sporophyte to gametophyte. The plant is the sporophyte (p. 59).

A zygospore is thus produced (in Spirogyra) that becomes encysted and falls to the bottom of the water, where, imbedded in the mud, it preserves the life of the plant until the next season. On the return of spring, the zygospore grows in the asexual way into a new filament. This is gonidial reproduction (p. 98).

Male gametes (in lichens), *spermatia*, conjugate with female gametes, *trichogynes*, inside the tissues of the hyphæ (p. 145).

A spore fruit results (in liverworts), and the spores develop by fission of cells into small and simple growths called *protonemæ*, from which new plants arise (p. 169).

Mosses are reproduced asexually by different modes of budding, but not, so far as is known, by asexual spores (p. 176).

The capsules (in mosses) containing the egg cells become filled with spores that closely resemble the asexual spores of some other plants (p. 177).

From this fact that their structure is wholly cellular, the plants of the preceding subdivisions are called *cellular cryptogams* (p. 183).

When the spores germinate (in pteridophytes), there is first formed a protonema which develops into a small thalloid leaf called *prothallium* (p. 185).

If the under side of one of these heart-shaped prothallia be examined under the microscope, special differentiations of the cells will be found near the sinus of the heart; these are the *archegonia* or *pistillidia;* they are rounded aggregations of cells,

with a large centrally situated cell that divides into two. Of these two cells, the lower develops into the egg cell, or oosphere; the upper develops into a tube which becomes filled with a mucilaginous substance that is afterwards discharged, leaving the passage to the oosphere open.

More distant from the sinus of the prothallium are the *antheridia*, situated among the root hairs. In these spirally coiled antherozoids are developed, being finally discharged by the rupture of the cell wall. Accompanying each antherozoid is a small cell, the use of which is not understood. Each antherozoid is provided with cilia, by means of which it swims about when the prothallium is wet. It may in this way pass to other prothallia, where, by fertilizing the oosphere, a hybrid variety is produced (p. 185).

Two groups of plants included here are *heterosporous*, *i. e.*, they have two kinds of spores, female macrospores and male microspores (p. 186).

The plant is the sporophyte (the spermatophytes). There are two kinds of spores, microspores or pollen grains, and macrospores borne in embryo sacs (p. 205).

The feature that especially distinguishes the spermaphytes from the plants of the seven preceding subdivisions is the production of true seeds, which are the result of the fertilization of the embryo cell by the receipt of the contents of the pollen cell. The embryo cell is borne in a pistil (p. 206).

The ovules are borne in closed cavities, the *ovaries*, at the base of *pistils*, which are modified leaves; the pollen cells are borne in anthers raised on stamens; which are also modified leaves (p. 218).

The contents of the pollen grain now mingle with those of the embryo sac, and the life of the seed commences (p. 219).

Some plants develop their leaves alternately; others develop them in pairs. From these facts have arisen a division of the angiosperms (into monocotyls and dicotyls) (p. 220).

The above quotations need no comment, and could some of the illustrations be reproduced the same remark would be appropriate, although some well-known and classic illustrations help the general average.—J. M. C.

Essays on plant life.

POPULAR books about plants are few. Accurate and interesting books about plants are rare indeed. We justly welcome, therefore, a book, embodying these qualities, which has lately been issued by Dr. J. C. Arthur of Purdue University and Dr. D. T. McDougal of the University of Minnesota.[3] It consists of twelve essays, selected in equal numbers by the two authors from popular addresses and articles presented within the last few years. These have been more or less modified to adapt them to each other and to current botanical knowledge. It will not be amiss to quote the titles of the essays to indicate in a measure the compass of the book.

[3] ARTHUR, J. C., and MACDOUGAL, D. T.—Living plants and their properties; a collection of essays. Small 8vo., pp. x + 234. *figs. 28.* New York; Baker & Taylor. Minneapolis: Morris & Wilson. 1898.